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Cause-specific mortality after hospital discharge for suicide attempt or suicidal ideation: A cohort study in Piedmont Region, Italy

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ABSTRACT

Background: Suicide attempters are at higher risk of death than the general population. The present study aims to investigate the excess of all-cause mortality and cause-specific mortality in a cohort of patients who have attempted suicide or had suicidal ideation compared with the general population.
Method: The cohort included 826 patients residing in the Piedmont Region of Northwest Italy who were admitted to a hospital or emergency department for suicide attempts or suicidal ideation between 2010 and 2016. Mortality excesses of the study population compared to the general population were estimated by applying indirect standardization. Standardized Mortality Ratios and 95% Confidence Intervals were calculated for all-cause, and cause-specific, natural, and unnatural causes of death by gender and age.
Results: During the 7 years of follow-up, 8.2% of the study sample died. The mortality of suicide attempters and ideators was significantly higher than that of the general population. Mortality was about twice than expected from natural causes, and 30 times than expected from unnatural causes. The mortality due to suicide was 85 times higher than that of the general population, with an excess of 126 times for females. The SMRs for all-cause mortality decreased with increasing age.
Conclusions: Patients who access hospitals or emergency departments for suicide attempts or suicidal ideation are a frail group at high risk of dying from natural or unnatural causes. Clinicians should pay special attention to the care of these patients, and public health and prevention professionals should develop and implement appropriate interventions to timely identify individuals at higher risk for suicide attempts and suicidal ideation and provide standardized care and support services.

1. Introduction

Suicide attempters are at higher risk of death than the general population. Since the 1990s, several studies have consistently reported increased mortality in cohorts of suicide attempters, with estimates varying across countries (Nordentoft et al., 1993; Holley et al., 1998; Tejedor et al., 1999; Ostamo and Lönnqvist, 2001; Suominen et al., 2004a; Antretter et al., 2009; Finkelstein et al., 2015; Jokinen et al., 2015; Tidemalm et al., 2015; Mäki and Martikainen, 2017; Vuagnat et al., 2020). The largest excesses were observed for unnatural causes of death e.g., suicide, accidents, and undetermined (whether accidental or intentional) deaths, but also for natural causes (Nordentoft et al., 1993; Holley et al., 1998; Tejedor et al., 1999; Ostamo and Lönnqvist, 2001; Suominen et al., 2004a; Antretter et al., 2009; Finkelstein et al., 2015; Jokinen et al., 2015; Tidemalm et al., 2015; Mäki and Martikainen, 2017). In previous studies, the mortality excess for unnatural causes was particularly high within the first year after a suicide attempt (Tidemalm et al., 2015; Mäki and Martikainen, 2017). The risk of death was higher in elderly suicide attempters, but the excess compared to the general population was more pronounced in young adults (Nordentoft et al., 1993; Haukka et al., 2008; Finkelstein et al., 2015; Tidemalm et al., 2015; Han et al., 2016; Vuagnat et al., 2020). Life expectancy was

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drastically reduced, especially when the first attempt occurred at a young age (Jokinen et al., 2018).

Gender differences greatly affect the phenomenon. It is known that suicide attempts are more common in females (Iribarren et al., 2000; Bernal et al., 2007; Finkelstein et al., 2015; Tidemalm et al., 2015; Olfson et al., 2017a; Vuagnat et al., 2020). However, the risk of dying from suicide after a suicide attempt is generally higher in males (Iribarren et al., 2000; Haukka et al., 2008; Finkelstein et al., 2015; Han et al., 2016; Olfson et al., 2017a; Vuagnat et al., 2020). With regard to the excess suicide mortality rate over the general population, this appears to be greater in females than in males (Hall et al., 1998; Tejedor et al., 1999; Ostamo and Lönnqvist, 2001; Antretter et al., 2009; Tidemalm et al., 2015). Nevertheless, all-cause and natural-cause mortality excesses in male attempters vs. male general population exceed the excess of female attempers vs. female general population (Hall et al., 1998; Ostamo and Lönnqvist, 2001; Antretter et al., 2009; Mäki and Martikainen, 2017). In terms of years of life lost, the decline in life expectancy is consistently greater for males (18 years lost) than for females (11 years lost) (Jokinen et al., 2018).

Although several large cohort studies have been conducted in Northern Europe to investigate excess mortality among suicide attempters compared to the general population, much less attention has been paid to such research questions in Southern Europe. Italy is one of the European countries with a low prevalence of suicidality (Bernal et al., 2007; Eurostat Statistics; World Health Organization, 2021). However, suicide rates differ significantly between regions of the country, with higher rates in the north than in the south of Italy (Vichi et al., 2010; Istituto Nazionale di Statistica, 2019).

The present study aims to investigate the excess of all-cause and cause-specific mortality in a cohort of patients admitted to a hospital or emergency department in the Piedmont Region of North-Western Italy, for suicide attempts or suicidal ideation between 2010 and 2016, compared to the general population.

2. Methods

2.1. Study sample

The cohort included 826 patients residing in Piedmont, a region of 4.4 million inhabitants in North-Western Italy, who were admitted to hospital or emergency department (ED) for a suicide attempt or suicidal ideation between January 1, 2010 and December 31, 2016.

Suicide attempt and suicidal ideation were defined according to the International Classification of Diseases, 9th revision (ICD-9), as recorded at hospital or emergency department discharge: suicide and self-inflicted injury (codes E950-E959), undetermined injury - whether accidently or intentionally inflicted (codes E980-E989) and suicidal ideation (code V62.84).

All patients who had at least one suicide attempt or suicidal ideation during the study period were included in the cohort. If there was more than one episode of suicide attempt or suicidal ideation, the first episode that occurred during the study period was used to define the patients' date of entry into the cohort. At the time of entry into the cohort, according to hospital discharge records, 668 patients were registered with suicidal ideation, while 158 were registered with suicide attempts. In order to allow record-linkage of administrative and health data, only individuals who resided in Piedmont at the time of hospital discharge or ED were included in the cohort. Due to a less reliable diagnosis, patients younger than 12 years were excluded from the study. Patients were followed until death, emigration or the end of the study. Follow-up began on the date of discharge from the hospital or ED. All patients were followed up longitudinally for up to 7 years, i.e., follow-up ended on December 31, 2016.

2.2. Data collection

Information on the patients in the study was collected by linking administrative and health data from the Piedmont Longitudinal Study. Linkage of the data archives was done using an anonymous identification code under the frame of the National Statistics Act, which legitimises the use and linkage of data for scientific purposes without the need for ethics committee approval.

The following data sources were used: 2011 Population Census of Piedmont Region and NHS Regional Population Register for socio-demographic characteristics; hospital discharge and emergency department databases for health-related conditions and diagnoses; and Mortality Register of the Piedmont Region for deaths and causes of death. Information on the size, gender, and age of the general population of the Piedmont region was extracted from the Official Statistics System of Piedmont Region (PISTA).

2.3. Measures

The following socio-demographic characteristics were extracted: gender, date of birth, age at index episode of suicide attempt or suicidal ideation, citizenship, marital status, education, occupation, and family composition.

Causes of hospital admission were coded according to the International Classification of Diseases, 9th Revision (ICD-9 codes). Psychiatric disorders were categorized into the following groups: schizophrenia [schizophrenic disorders (codes 295–295.95), other non-organic psychoses (codes 297–298.9)]; bipolar disorders (codes 296.0–296.16, 296.4–296.81, 296.89); personality disorders (codes 301–301.9); depressive disorders (codes 296.2–296.36, 300.4, 311); drug and alcohol dependence (codes 291–292.9, 303–305.93); anxiety disorders (codes 300.0–300.3, 300.5–300.9); adjustment disorders [adjustment reaction (codes 309–309.9), acute reaction to stress (codes 308–308.9)]; others [dementias (codes 290–290.9), other mental disorders due to organic condition (codes 293–294.9)]. Physical illnesses were categorized into the following groups: malignant neoplasm (codes 140–208.91); neurological disorders [Alzheimer's disease (code 331.0), Parkinson's disease (codes 332–332.1), extrapyramidal diseases and myelopathies (codes 333–336.9), disorders of autonomic nervous system (codes 337–337.9), multiple sclerosis (code 340), epilepsy and recurrent seizures (codes 345–345.91), migraine (codes 346–346.91), disorders of peripheral nervous system (codes 350–359.9)]; diabetes mellitus (codes 250–250.93); cardiovascular diseases [hypertension (codes 401–405.99), ischemic heart disease (codes 410–414.9), cerebrovascular disease (codes 430–438.9)]; others [HIV (code 042), pain (codes 307.8–307.89, 338–338.4), chronic obstructive pulmonary disease and allied conditions (codes 490–496), dorsopathies (codes 720–724.9), osteoporosis (codes 733.0–733.09), skull fracture (codes 800–804.99), intracranial injury (codes 850–854.19)].

Hospital admissions, as collected from the Hospital Discharge database, were calculated by summing up the number of times the patient was admitted to the hospital during their lifetime.

Causes of death were classified according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10 codes), and for the scope of this study were grouped into the following categories: neoplasms (codes C00-D48), endocrine, nutritional, and metabolic diseases (codes E00-E90), mental and behavioural disorders (codes F00–F99), diseases of the nervous system and sense organs (codes G00-H95), disease of the circulatory system (codes I00–I99), diseases of the respiratory system (codes J00-J99), diseases of the digestive system (codes K00–K93), diseases of the genitourinary system (codes N00–N99), accidents (codes V01-X59), suicides (codes X60-X84) and undetermined intent (Y10–Y34).

2.4. Statistical analysis

Descriptive statistics were used to describe the socio-demographic characteristics and health status of the study cohort by gender.

Mortality excesses of the study population compared to the general population of the Piedmont Region were estimated by applying indirect standardization and calculating Standardized Mortality Ratios (SMR). SMRs and 95% Confidence Intervals were calculated for all-cause, and cause-specific, natural, and unnatural-causes of death by gender, age categories, and suicide subgroup. The 95% CI was obtained by calculating the squared root of observed deaths, z-score and standard error of SMRs. For each patient in the cohort, person-years were calculated starting from the year of the index episode to the year of death or the end of follow-up. Person-years of the study population were then multiplied by death rates of the general population for each gender and age stratum for the entire period of observation obtaining the expected number of deaths. The total number of expected deaths of each cause-group was obtained by summing up the stratified expected number of deaths by age and gender. SMRs were estimated as ratios between the number of observed and expected deaths applying gender, age, and cause-specific mortality rates.

3. Results

3.1. Characteristics of the study population

The characteristics of the study sample are described in Table 1.

From 2010 to 2016, 826 patients (2517 person-years) were admitted to the hospital or emergency department for suicide attempts or suicidal ideation: 393 (47.6%) were males and 433 (52.4%) were females. The mean age was 45 years (±18.6), males being older than females (47.9 vs. 42.5, $p < 0.001$). At first suicide attempt or suicidal ideation, most patients were 30–59 years old (57.9%), 3.6% were 12–14 years old and 7.6% were older than 75 years. Among patients who attempted suicide or had suicidal ideation, a greater population of females than males were under age 30 (26.3% vs. 16.8%), with females being over-represented also in the 12–14 year old group (6.0% vs. 1.0%), whereas a greater proportion of males attempted or ideated suicide after 75 years of age (10.2% vs. 5.3%) ($p < 0.001$).

Eighty-two percent of patients were Italian citizens, 57.3% were alone (unmarried, separated or divorced, widowed), 45.8% had middle education level; 33.5% were employed; about one-third lived in families of couples with children (35.1%), followed by single (21.1%), couples without children (15.6%) and single-parent families (14.2%). No differences were observed for citizenship, marital status, and education level, whilst occupation and family composition significantly differed between males and females ($p < 0.001$, and $p = 0.032$, respectively). Forty-one percent of males vs. 26.8% of females were employed; 8.4% of males and 9.2% of females were unemployed; and a higher proportion of males were retired (21.6% vs. 14.3% females). A higher proportion of females lived in families of couples with children (37.4% vs. 32.6%) and in single-parent families (16.9% vs. 11.2%), whereas males prevailed in families without children (17.6% vs. 13.9%) and in a single category (23.4% vs. 18.9%).

About one-third of patients had a lifetime diagnosis of schizophrenia (30.9%), 19.3% of personality disorders, and 16.1% of depressive disorders. Only 14.2% of patients had no record of psychiatric diagnosis at all. Schizophrenia, bipolar disorders, personality disorders, and anxiety disorders were more prevalent among females, whereas depressive disorders, and drug and alcohol dependence among males ($p = 0.006$).

As regards physical illness, 15% of patients had a diagnosis of neurological disorders, 11.6% of cardiovascular diseases, 10.1% of malignant neoplasms, and 4.6% of diabetes mellitus. Only 38.1% of patients had no record of physical illness at all. Neurological disorders were more prevalent among females, whereas malignant neoplasms and cardiovascular diseases among males (<0.001).

On average, patients were admitted 10.5 (±16.9) times to hospital during their lifetime.

During the follow-up period, 8.2% of patients died (11.4% of males vs. 5.3% of females, $p = 0.001$).

Sixty-six percent of patients entered the cohort with a first episode of suicide attempt or ideation registered in ED (158 attempters and 388 ideators), and 33.9% in hospital (only ideators, $n = 280$).

3.2. Cause-specific mortality

Compared with the general population, suicide attempters and ideators had a statistically significant excess in all-cause mortality (SMR 3.83, 95%CI 2.97–4.85), with an excess of 3.99 (95%CI 2.91–5.34) times among males and 3.54 (95%CI 2.24–5.31) among females (Table 2). Mortality from natural causes was about twice as high as expected, with an SMR of 2.62 (95%CI 1.74–3.79) among males and 2.39 (95%CI 1.34–3.95) among females. Suicide attempters and ideators had a 3.34-fold higher risk of dying from neoplasms, 5.75 times from nervous-system diseases, and 2.04 times from diseases of circulatory system than the general population. The excess mortality from neoplasms was statistically significant among males and females, and from diseases of circulatory system only among males.

The excess mortality was particularly high for unnatural causes (SMR 30.99, 95%CI 20.03–45.78). The risk of dying from suicide was 85.50 times higher and from accidents 9.58 times higher than that of the general population. The mortality risk was higher than expected in both genders, with an SMR of 35.17 among females and 29.35 among males for all unnatural causes; SMR 126.26 among females, and 72.84 among males for suicide. Mortality from accidents was significantly higher than expected among males (SMR 10.73), but not among females.

3.3. Age-specific mortality

Excesses of mortality by age are shown in Table 3.

Among suicide attempters and ideators, the mortality was significantly higher than among the general population for all age groups, except the oldest, and it was particularly high among 15–44 years old. The excess decreased with increasing age. Mortality from natural causes was significantly higher than expected in patients aged 45–74, while the mortality from unnatural causes was significantly higher in all age groups, with a 42-fold excess in the 15–29 year old patients and even a 59-fold excess in the 30–44 year old ones.

3.4. Mortality of suicide attempters vs. suicide ideators

Mortality excesses of suicide attempters and ideators are shown in Table 4.

In the cohort, 10.1% of suicide attempters and 7.8% of suicide ideators died during follow-up. When compared to the general population, the mortality was 3.48 times higher among suicide attempters and 3.95 times among ideators. Suicide ideators had 2.95 times higher risk of dying from natural causes (SMR 3.97 for neoplasms and 7.86 for nervous-system diseases). The excess was not statistically significant for suicide attempters. Mortality excess from unnatural causes was particularly high (SMR 53.32 for suicide attempters and 24.23 for suicide ideators). The risk of dying from suicide was 164.80 times higher among attempters and 64.73 times among ideators compared to the general population. Mortality due to accidents was 15.91 times higher among suicide attempters and 7.57 times higher among ideators than in the general population.

4. Discussion

We conducted a cohort study by linking health and administrative data from the Piedmont Region. In doing so we prospectively followed 826 patients admitted to the hospital or emergency department for a

Table 1
Characteristics of patients admitted to hospital or emergency department for suicide attempt or suicidal ideation between 2010 and 2016, Piedmont Region, Italy.

Characteristics	Suicide attempters or ideators						
	Overall (N = 826)		Males (N = 393)		Females (N = 433)		P
	n	%	n	%	n	%	
Age (years)							
Mean ± SD	45.0	±18.6	47.9	±18.5	42.5	±18.4	<0.001
Age groups (years)							
12-14	30	3.6	4	1.0	26	6.0	<0.001
15-29	150	18.2	62	15.8	88	20.3	
30-44	222	26.9	109	27.7	113	26.1	
45-59	256	31.0	125	31.8	131	30.3	
60-74	105	12.7	53	13.5	52	12.0	
75+	63	7.6	40	10.2	23	5.3	
Citizenship							
Italian	676	81.8	320	81.4	356	82.2	0.097
Foreign	54	6.5	20	5.1	34	7.9	
Missing	96	11.6	53	13.5	43	9.9	
Marital status							
Married	257	31.1	128	32.6	129	29.8	0.302
Unmarried	315	38.1	143	36.4	172	39.7	
Separated/Divorced	112	13.6	51	13.0	61	14.1	
Widowed	46	5.6	18	4.6	28	6.5	
Missing	96	11.6	53	13.5	43	9.9	
Education							
University	36	4.4	15	3.8	21	4.9	0.230
High school	157	19.0	70	17.8	87	20.1	
Middle school	378	45.8	181	46.1	197	45.5	
Elementary school	125	15.1	63	16.0	62	14.3	
None	34	4.1	11	2.8	23	5.3	
Missing	96	11.6	53	13.5	43	9.9	
Occupation							
Employed	277	33.5	161	41.0	116	26.8	<0.001
Unemployed	73	8.8	33	8.4	40	9.2	
Retired	147	17.8	85	21.6	62	14.3	
Other[a]	180	21.8	51	13.0	129	29.8	
Missing	149	18.0	63	16.0	86	19.9	
Family composition							
Couple with children	290	35.1	128	32.6	162	37.4	0.032
Couple without children	129	15.6	69	17.6	60	13.9	
Single parent	117	14.2	44	11.2	73	16.9	
Single	174	21.1	92	23.4	82	18.9	
Other[b]	14	1.7	5	1.3	9	2.1	
Missing	102	12.4	55	14.0	47	10.9	
Psychiatric diagnosis							
No	117	14.2	63	16.0	54	12.5	0.006
Schizophrenia	255	30.9	113	28.8	142	32.8	
Bipolar disorder	44	5.3	20	5.1	24	5.5	
Personality disorder	159	19.3	65	16.5	94	21.7	
Depressive disorder	133	16.1	71	18.1	62	14.3	
Drug and alcohol dependence	46	5.6	31	7.9	15	3.5	
Anxiety disorders	36	4.4	11	2.8	25	5.8	
Adjustment disorders	28	3.4	13	3.3	15	3.5	
Others[c]	8	1.0	6	1.5	2	0.5	
Physical illness diagnosis							
No	315	38.1	139	35.4	176	40.6	<0.001
Malignant neoplasms	83	10.1	44	11.2	39	9.0	
Neurological disorders	124	15.0	50	12.7	74	17.1	
Diabetes Mellitus	38	4.6	19	4.8	19	4.4	
Cardiovascular diseases	96	11.6	66	16.8	30	6.9	
Others[d]	170	20.6	75	19.1	95	21.9	
Hospital admissions in lifetime							
Mean ± SD	10.5	±16.9	9.3	±13.5	11.5	±19.4	0.611
Deaths							
No	758	91.8	348	88.6	410	94.7	0.001
Yes	68	8.2	45	11.4	23	5.3	

SD=Standard Deviation.
[a] Other: student, housewife, other conditions.
[b] Other: families with two or more nucleus.
[c] Others: dementias and other mental disorders due to organic condition.
[d] Others: HIV, pain, chronic obstructive pulmonary disease and allied conditions, dorsopathies, osteoporosis, skull fracture, and intracranial injury.

Table 2
Standardized Mortality Ratio of suicide attempters and ideators by gender and causes of death.

Cause of death	ICD-10[a]	Overall			Males			Females		
		O	E	SMR (95% CI)	O	E	SMR (95% CI)	O	E	SMR (95% CI)
All causes		68	17.77	**3.83 (2.97–4.85)**	45	11.28	**3.99 (2.91–5.34)**	23	6.50	**3.54 (2.24–5.31)**
Natural causes		43	16.97	**2.53 (1.83–3.42)**	28	10.70	**2.62 (1.74–3.79)**	15	6.27	**2.39 (1.34–3.95)**
Neoplasms	C00-D48	20	5.99	**3.34 (2.04–5.16)**	11	3.87	**2.84 (1.41–5.09)**	9	2.11	**4.26 (1.94–8.09)**
Endocrine, nutritional and metabolic diseases	E00-E90	2	0.61	3.28 (0.37–11.86)	1	0.37	2.72 (0.03–15.18)	1	0.24	4.12 (0.05–22.99)
Mental and behavioral disorders	F00–F99	1	0.53	1.89 (0.02–10.52)	1	0.28	3.58 (0.05–19.97)	0	–	–
Diseases of the nervous system and sense organs	G00-H95	4	0.70	**5.75 (1.54–14.75)**	2	0.41	4.87 (0.54–17.63)	2	0.29	7.02 (0.78–25.37)
Diseases of the circulatory system	I00–I99	12	5.89	**2.04 (1.05–3.57)**	10	3.66	**2.73 (1.31–5.03)**	2	2.22	0.90 (0.10–3.25)
Diseases of the respiratory system	J00-J99	2	1.34	1.49 (0.17–5.40)	1	0.95	1.05 (0.01–5.85)	1	0.39	2.59 (0.03–14.45)
Diseases of the digestive system	K00–K93	1	0.69	1.44 (0.02–8.04)	1	0.45	2.24 (0.03–12.47)	0	–	–
Diseases of the genitourinary system	N00–N99	1	0.27	3.70 (0.05–20.65)	1	0.18	5.54 (0.07–30.91)	0	–	–
Unnatural causes		25	0.81	**30.99 (20.03–45.78)**	17	0.58	**29.35 (17.07–47.03)**	8	0.23	**35.17 (15.12–69.39)**
Accidents	V01-X59	5	0.52	**9.58 (3.08–22.39)**	4	0.37	**10.73 (2.88–27.50)**	1	0.15	6.71 (0.09–37.42)
Suicide	X60-X84	20	0.23	**85.50 (52.15–132.16)**	13	0.18	**72.84 (38.69–124.68)**	7	0.06	**126.26 (50.48–260.47)**
Undetermined intent	Y10–Y34	0	–	-	0	–	-	0	–	-

SMR = Standardized Mortality Ratio; O = Observed death; E = Expected death; CI = Confidence Interval.
Statistically significant SMRs are marked in bold.
[a] ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision.

Table 3
Standardized Mortality Ratio of suicide attempters and ideators by age.

	All causes			Natural causes			Unnatural causes		
	O	E	SMR (95% CI)	O	E	SMR (95% CI)	O	E	SMR (95% CI)
Age (years)									
12–14	0	–	-	0	–	-	0	–	-
15–29	3	0.13	**24.07 (4.82–70.45)**	0	–	-	3	0.07	**41.66 (8.34–121.92)**
30–44	9	0.49	**18.30 (8.34–34.79)**	1	0.36	2.81 (0.04–15.68)	8	0.14	**58.82 (25.28–116.03)**
45–59	14	2.10	**6.66 (3.64–11.19)**	8	1.92	**4.17 (1.79–8.23)**	6	0.18	**32.84 (11.96–71.57)**
60–74	25	3.54	**7.06 (4.56–10.43)**	21	3.43	**6.12 (3.78–9.36)**	4	0.11	**36.47 (9.78–93.50)**
75+	17	11.51	1.48 (0.86–2.37)	13	11.20	1.16 (0.62–1.99)	4	0.30	**13.16 (3.53–33.73)**

SMR = Standardized Mortality Ratio; O = Observed death; E = Expected death; CI = Confidence Interval.
Statistically significant SMRs are marked in bold.

Table 4
Standardized Mortality Ratio by suicide attempters and ideators and causes of death.

Cause of death	ICD-10[a]	Suicide attempters			Suicide ideators		
		O	E	SMR (95% CI)	O	E	SMR (95% CI)
All causes		16	4.59	**3.48 (1.99–5.66)**	52	13.18	**3.95 (2.94–5.18)**
Natural causes		6	4.40	1.36 (0.50–2.97)	37	12.56	**2.95 (2.07–4.06)**
Neoplasms	C00-D48	2	1.46	1.37 (0.15–4.96)	18	4.53	**3.97 (2.35–6.29)**
Endocrine, nutritional and metabolic diseases	E00-E90	0	0	–	2	0.45	4.47 (0.50–16.16)
Mental and behavioral disorders	F00–F99	0	0	–	1	0.38	2.65 (0.03–14.80)
Diseases of the nervous system and sense organs	G00-H95	0	0	–	4	0.51	**7.86 (2.11–20.14)**
Diseases of the circulatory system	I00–I99	3	1.59	1.89 (0.38–5.53)	9	4.30	2.09 (0.95–3.98)
Diseases of the respiratory system	J00-J99	1	0.35	2.86 (0.04–15.95)	1	0.99	1.01 (0.01–5.64)
Diseases of the digestive system	K00–K93	0	0	–	1	0.52	1.92 (0.02–10.73)
Diseases of the genitourinary system	N00–N99	0	0	–	1	0.20	5.05 (0.06–28.17)
Unnatural causes		10	0.19	**53.32 (25.48–98.16)**	15	0.62	**24.23 (13.53–39.99)**
Accidents	V01-X59	2	0.13	**15.91 (1.78–57.53)**	3	0.40	**7.57 (1.52–22.16)**
Suicide	X60-X84	8	0.05	**164.80 (70.83–325.10)**	12	0.19	**64.73 (33.36–113.19)**
Undetermined intent	Y10–Y34	0	0	-	0	0	-

SMR = Standardized Mortality Ratio; O = Observed death; E = Expected death; CI = Confidence Interval.
Statistically significant SMRs are marked in bold.
[a] ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision.

suicide attempt or suicidal ideation over a 7-year period from the date of the first attempt or ideation until death or the end of follow-up. To our knowledge, this is the first study to examine excess mortality due to natural and unnatural causes in patients with suicide attempts or suicidal ideation in Italy. Most previous cohorts in this domain were conducted in Northern-European countries, and therefore our study provides new evidence from the Southern-European context. In our study, the mortality of suicide attempters and ideators significantly exceeded that of the general population, both for natural-causes (more than 2 times higher) and for unnatural-causes (more than 30 times higher). Mortality due to suicide was 85 times higher than that of the general population, with an excess of 126 times among females, and 164

times among suicide attempters. The SMR for all-cause mortality decreased with increasing age.

Several studies have been conducted in Southern Europe exploring the trends and characteristics of suicide attempters (Tejedor et al., 1999; Scocco et al., 2008; Slama et al., 2009; Kõlves et al., 2011; Blasco-Fontecilla et al., 2012; Monnin et al., 2012; Preti, 2012; Pavarin et al., 2014; Lopez-Castroman et al., 2016; Parra-Uribe et al., 2017; Irigoyen et al., 2019). Similarly to what was observed in a French sample of suicide attempters, most patients were women, middle-aged and unmarried, widowed and divorced (Monnin et al., 2012). The mean age was analogous to that of a study conducted in the metropolitan area of Bologna in Northern Italy (Pavarin et al., 2014). More young females than males were admitted to the hospital for suicide attempts (Iribarren et al., 2000; Blasco-Fontecilla et al., 2012; Tidemalm et al., 2015). About 80% had a concurrent diagnosis of mental illness, while about 60% were affected by physical illness, a finding documented elsewhere (Goodwin et al., 2003; Bernal et al., 2007; Tidemalm et al., 2008; Runeson et al., 2016; Olfson et al., 2017b). Anxiety was more prevalent among females, and drug and alcohol dependence among male patients (Monnin et al., 2012). Overall 8.2% of patients died during the follow-up, less than 12.1% observed in the above-mentioned study by Pavarin et al. (2014). In line with previous studies, more males died than females (Ostamo and Lönnqvist, 2001; Suominen et al., 2004b; Christiansen and Jensen, 2007; Haukka et al., 2008; Vuagnat et al., 2020).

The estimated fourfold higher risk of dying from all causes in our sample compared to the general population is significantly lower than reported in most other European studies (Nordentoft et al., 1993; Holley et al., 1998; Tejedor et al., 1999; Suominen et al., 2004a; Mäki and Martikainen, 2017; Vuagnat et al., 2020), but it is higher than what reported in studies from UK and Austria (Hall et al., 1998; Antretter et al., 2009). The discrepancy in excess mortality could be due to the different socio-cultural and socio-economic circumstances in Southern Europe, but also to the differences in patient enrolment methods, inclusion criteria and duration of follow-up in the individual studies.

An excess risk of death from natural causes in patients who attempted suicide was commonly observed in the literature (Nordentoft et al., 1993; Hall et al., 1998; Tejedor et al., 1999; Ostamo and Lönnqvist, 2001; Antretter et al., 2009; Finkelstein et al., 2015; Jokinen et al., 2015; Mäki and Martikainen, 2017). In our study, a significantly elevated risk of death from natural causes was found in the overall sample, and among suicide ideators, while it did not reach statistical significance among suicide attempters, probably due to the low statistical power of the subgroup of suicide attempters. Natural-cause mortality excess among suicidal patients may be attributable to the high prevalence of psychiatric disorders, increasing the risk of tobacco, alcohol, and substance use, unhealthy behaviours, overweight, and obesity (Scott and Happell, 2011; Henderson et al., 2015; Penninx, 2017; Penninx and Lange, 2018; Nielsen et al., 2021), and of physical health problems (Goldman-Mellor et al., 2014). Moreover, physical illness, especially in presence of psychiatric disorders, may trigger suicidal behaviour (De Leo et al., 1999; Goodwin et al., 2003; Bahk et al., 2011; Stickley et al., 2020). Consistently, in our cohort, only 14% of the sample did not have a record of concurrent psychiatric diagnosis, and we observed a high prevalence of mental and physical health problems.

As far as unnatural causes of death are concerned, our study confirms the generally known higher risk of death compared to the general population. However, the excess mortality for suicide was higher than reported in most previous studies and, as expected, even higher when considering the subgroup of suicide attempters compared to suicide ideators (Nordentoft et al., 1993; Holley et al., 1998; Suominen et al., 2004a; Antretter et al., 2009; Finkelstein et al., 2015; Mäki and Martikainen, 2017).

As regards gender, the overall excess risk of mortality was 3.99 times higher among males, and 3.54 times higher among females compared to their counterparts from the general population, consistent with previous studies (Hall et al., 1998; Ostamo and Lönnqvist, 2001; Antretter et al., 2009; Mäki and Martikainen, 2017). The mortality excess for circulatory-system diseases was significant among males, similar to other European longitudinal studies (Hall et al., 1998; Ostamo and Lönnqvist, 2001; Antretter et al., 2009), and coherently with the high proportion of males having a concurrent diagnosis of cardiovascular diseases. In the case of unnatural causes of death, suicide mortality was about 120 times higher among females compared with the general population, and about 70 times higher among males, as already reported elsewhere (Hall et al., 1998; Tejedor et al., 1999; Ostamo and Lönnqvist, 2001; Antretter et al., 2009). This is possibly suggesting that a recurrence of attempts in a frail population subgroup as females with poor mental health and concurrent psychiatric conditions could really lead to a suicide death. Indeed, we observed that female suicide attempters are more likely to have a medical record diagnosis of a psychiatric disorder than males, a condition closely related to suicide (Tidemalm et al., 2008; Finkelstein et al., 2015; Probert-Lindström et al., 2020). On the contrary, the excess of mortality due to accidents was significantly higher among males, but not among females. This could be due to a higher prevalence of traumatic accidents in males vs. females, and a consequent underpower of the study to detect an excess among females; and to a certain level of misclassification (in hospital discharge reports), or even to "hidden" suicides (e.g. intentional car accidents). Consistently, a greater excess of accidental death among males was observed in UK and Finnish cohorts of suicide attempters (Hall et al., 1998; Ostamo and Lönnqvist, 2001).

When compared to the general population, the overall and unnatural mortality excesses were particularly high in young adults aged 15–44 years, similar to what was observed in several other European cohorts (Nordentoft et al., 1993; Jokinen et al., 2018; Vuagnat et al., 2020). It is possible that younger people with mental health problems may be less likely to seek help (Oliver et al., 2005).

This study has a number of strengths. This is the first study to examine the excess of mortality in a cohort of patients who attempted and ideated suicide in the Italian context. The sample included all attempts and ideations referred from hospitals and emergency departments in the region, irrespective of the method of suicide attempt. Several information on the study patients were linked from administrative and health registers ensuring the richness of the data. The completeness of the mortality data was high. The standardized mortality rates were used to estimate observed versus expected mortality, taking into account differences in gender and age structure of the populations. However, the study results should be considered also in light of some limitations. Suicide attempts may be underestimated due to misclassification and underreporting of cases, i.e. those who do not come to the emergency room or hospital and those who are registered with other diagnoses, e.g. accidents. Therefore, the sample may not be representative of all suicide attempts in the regional catchment area, but rather biased towards the most severely affected cases, i.e. those requiring emergency evaluation and/or hospital treatment. Some results may not be statistically significant or may even result in type I and type II errors due to the low number of cases in specific subgroups. The cohort is long enough to examine the risk for some causes of death, but it may not be sufficient to identify some natural causes of death that need longer latency. Finally, comparing the results of different studies can be difficult because of the unclear and inconsistent definition of suicide attempt, which sometimes includes self-harming acts with and without suicidal intent.

In conclusion, patients who visit the emergency department or hospital because of suicide attempts or suicidal ideation are a frail group at high risk of dying not only from unnatural causes but also from natural causes. These findings suggest that clinicians should pay particular attention to the care and follow-up of such patients. Public health and prevention professionals should design and implement network interventions to timely identify individuals at higher risk for suicide attempts and suicidal ideation by establishing standardised pathways of care and support.

Authors contributions

Federica Vigna-Taglianti, Roberto Diecidue, Giuseppe Costa, Giuseppe Maina and Gianluca Rosso designed the study. Gian Luca Cuomo extracted the data, performed preliminary analyses and created the dataset. Emina Mehanović and Federica Vigna-Taglianti drafted the paper. Emina Mehanović carried out the statistical analysis. All authors provided critical revision, contributed to and approved the final manuscript.

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Ethical standards

Linkages among archives of socio-demographic and health data were performed using the anonymous identification code attributed to subjects in the framework of the Piedmont Longitudinal Study. The National Statistical Act legitimates the Piedmont Longitudinal Study to the use and linkage of data for scientific purposes without the need of an Ethical Committee approval.

Submission declaration

The article has not been published previously and it is not currently under consideration by other journals. All authors have been personally and actively involved in substantive work leading to the report, they participated to the revision of the article and they have been provided a copy of this submission. The final revised version of the article is approved by all authors.

Revised version of the article

The manuscript "Cause-specific mortality after hospital discharge for suicide attempt or suicidal ideation: a cohort study in Piedmont Region, Italy" was modified according to the comments of the reviewers.

I also attached our point-by-point response to the reviewers' comments.

Declaration of competing interest

None.

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